TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 188 APRIL, 1916

# TILE DRAINAGE

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

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# TEXAS AGRICULTURAL EXPERIMENT STATION

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# TILE DRAINAGE

BY

A. H. LEIDIGH, B. S., Agronomist

AND

E. C. GEE, B. S. Ag. E., Professor of Agricultural Engineering
Agricultural and Mechanical College of Texas

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# AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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*As of April 1, 1916.
**In cooperation with United States Department of Agriculture.

## CONTENTS.

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## ILLUSTRATIONS.

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# TILE DRAINAGE.

BY A. H. LEIDIGH, B. S., AGRONOMIST, AND E. C. GEE, B. S. AG. E., PROFESSOR OF AGRICULTURAL ENGINEERING, AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

The most favored fields in Texas are increasing in value. As this increase continues we shall be well paid for the expense involved in bringing adjoining and similar fields to a like earning power. In many cases where a field is making low yields the sole cause is lack of proper drainage, which may be secured at a nominal cost. The people of Texas have been so busy developing their resources that they have not given much study to the problem of how to reclaim their wet and boggy land. In fact, with few exceptions they have not as yet reclaimed or made more productive the land that is springy or subject to overflow. Furthermore, not enough attention has been given to irrigated lands that have been ruined by deposits of alkali.

For three years the authors have each been collecting facts relative to drainage in Texas. In 1913 Mr. Gee visited thirty-one counties in the State while investigating the cost, methods, and practicability of tile drainage systems. The information then collected is used in his classes in agricultural engineering and in answering correspondents. Likewise, Mr. Leidigh, in his work for the Texas Agricultural Experiment Station, has visited many drained fields and localities, in an effort to observe the results obtained from a crop-producing viewpoint. Because the subject has thus been under observation from the two standpoints, it has seemed justifiable to issue a joint publication, so that the information may be made available to those who can profitably make use of it.

When soil is too wet, free water stands in it. The prevalence of such a condition for any great length of time during the growing season, is unfavorable to the best development of ordinary crops. Such soils need to be drained. Two methods of draining agricultural land are in common use. These are:

(1) By means of ditches.

(2) By means of underground tile.

This bulletin relates to both of these methods, but most attention is paid to draining by means of tile.

This bulletin will take up the subject of drainage, as follows:

Benefits of drainage.
Conditions under which drainage is necessary.
Lands in Texas needing drainage.
Tile drains and open ditches compared.
Systems of tile drainage in use.
How to install a tile drainage system.
Cost, care, and upkeep of tile drainage systems.

## BENEFITS OF DRAINAGE.

Drainage improves a soil in the following ways:

(1) Removes surplus water and admits air.
(2) Enables roots to go deeper.
(3) Aids in pulverization of the soil.
(4) Increases the drouth resistance of soils.
(5) Makes manure and decaying matter available as plant foods.
(6) Makes the soil warm up early in the spring.
(7) Removes alkali.

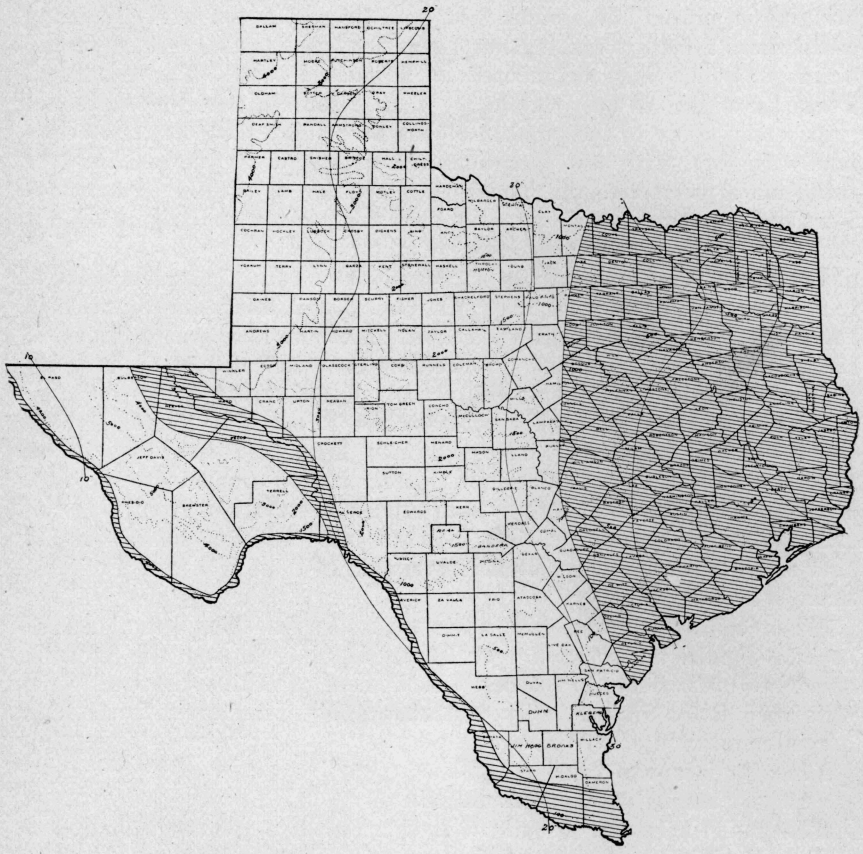

Figure 1. Drainage Map of Texas.

Briefly, the manner in which drainage brings about each of these conditions, is as follows:

The soil is made up of very small grains of sand, silt, clay, and so forth, which rest one against another. Water clings to the soil grains. Between the soil particles are many very small spaces. In the spaces are air and water, and into them the roots grow. Now if too much water is present it fills up the air spaces, but this surplus water will immediately run out again if it has an opportunity. The water which the force of capillarity holds in the soil will not run out. This capillary water is beneficial to plants and they use it.

The roots of crop plants do not develop very extensively in standing water. This is mostly because the water shuts out the air.

Drainage lowers the level of the surplus water in a wet soil. This brings into use much more of the soil than formerly, since before drainage only the soil near the surface was available for root growth. Roots of most crops need about three feet of soil for proper growth.

Air in the soil aids in the cracking and pulverizing of the soil and as rapidly as this progresses the air is brought into contact with other parts of the soil, which in their turn gradually become pulverized.

A very important result of drainage is that the drouth resistance of the soil is increased. This increase in the drouth resistance of a soil is due to a change in its capillary structure. A poorly drained soil is close and compact and the capillary channels are small but continuous. It will be seen that when hot, dry weather comes, such a soil will lose water very rapidly by evaporation. When a better structure is brought about and the soil is more completely pulverized the capillary channels are more plentiful, but they run in every direction. Thus while they have more capacity they are much shorter and less effective in causing evaporation. In other words, because of drainage the soil becomes of a more granular or mulch-like structure. The condition thus brought about extends deeper than just the surface soil. This pulverizing is not to be compared to the mulch we make with the plow. It is a fact, however, that we plow and cultivate to break up the capillary structure of soils and thereby save moisture.

As regards drouth resistance, drainage has a double function. It increases the space available for both surplus and capillary water, but because of the more porous structure of the soil, the surplus water is free to run at once into the tile. The capillary water is less free to move up to the surface and become lost. The final result of all these changes is that water available for crops is held in the soil for a longer time.

The formation of available plant food in the soil must be a continuous process. This is not the case in a water-logged soil, because air is needed and must circulate in the soil during the liberation of plant food. Manure and all other organic matter in the soil must have air for its decomposition and conversion into plant food. In a too wet soil these constituents are almost valueless. When the soil is too wet, certain food compounds are rendered unavailable or changed to injurious compounds; likewise, injurious acids accumulate and injure the roots. These various conditions seem to be due to a lack of air. This is caused by the air spaces being filled with water.

About one-half of the heat received by a wet soil goes to warm the surplus water it contains. Water in the soil warms very slowly, and hence a water-logged soil is cold, and crop development is greatly retarded. Because of standing water in a soil there is great evaporation from the surface. Since evaporation absorbs heat this makes the soil much colder and further delays its warming. For these reasons the actual growing season on a wet soil is shortened.

When soils are strongly alkaline or where they are receiving alkaline seepage water, crops may be benefited by drainage. These conditions are most frequently found in irrigated districts. Drainage removes the alkali.

## CONDITIONS UNDER WHICH DRAINAGE IS NECESSARY.

Fields where drainage may be needed to bring about some or all of the above named things are as follows:

(1) Low, flat, swampy fields.

(2) Bottom or bench land occasionally overflowed or containing seepy spots.

(3) Extremely flat land wherever there is much rainfall.

(4) Rice fields.

(5) Washy soils wherever there is much rainfall.

(6) Irrigated fields which show the effect of alkali.

Low, flat, swampy bottom lands nearly always need to be drained. Such land may be swampy because of insufficient outlet for natural drainage, overflow from streams, or excessive rainfall during the growing season. When any one or all of the foregoing conditions prevail, crop growth is unsatisfactory.

Bottom lands and bench lands near high ground frequently must be drained. Such locations are subject to underground seepage or surface wash from higher ground, which may be checked easily by intercepting an underground flow where the higher land joins the more level areas.

Extremely flat areas in regions of much rainfall always need to be drained. Such land may be either bottom or upland. These fields are sometimes wet for days at a time, following rains,—a condition that causes great loss, because it is a critical time in the crop season. Even in Western Texas there are many small areas where drainage is necessary. While the annual rainfall in some of these localities is not large, occasionally there are periods of very heavy downpours extending over a number of days. Often after these wet spells the crops are left under water and the field becomes water-logged. This is particularly true in level places having heavy soils or where there is a heavy subsoil. In these cases at small cost a great increase in return may be secured by drainage.

Rice fields require drainage at harvest time and throughout the winter. This problem is largely one of surface drainage by means of ditches and dikes, but where other crops are to be raised more efficient drainage is needed.

Lands which are either nearly level or hilly and which are subject to excessive gullying may be made more valuable by drainage. The underlying causes of washing may be:

(1) The heavy rainfall.

(2) The easily washed subsoil.

(3) The run-down condition of the land caused by poor tillage methods and humus depletion.

(4) The somewhat impervious soils which absorb little water, and, therefore, force most of it to flow away unabsorbed.

The soils of class (4) just named, when underlaid by easily washed subsoils, are the most disastrously washed and gullied. Generally, this class of drainage-needing land combines within itself conditions brought about by all the foregoing causes.

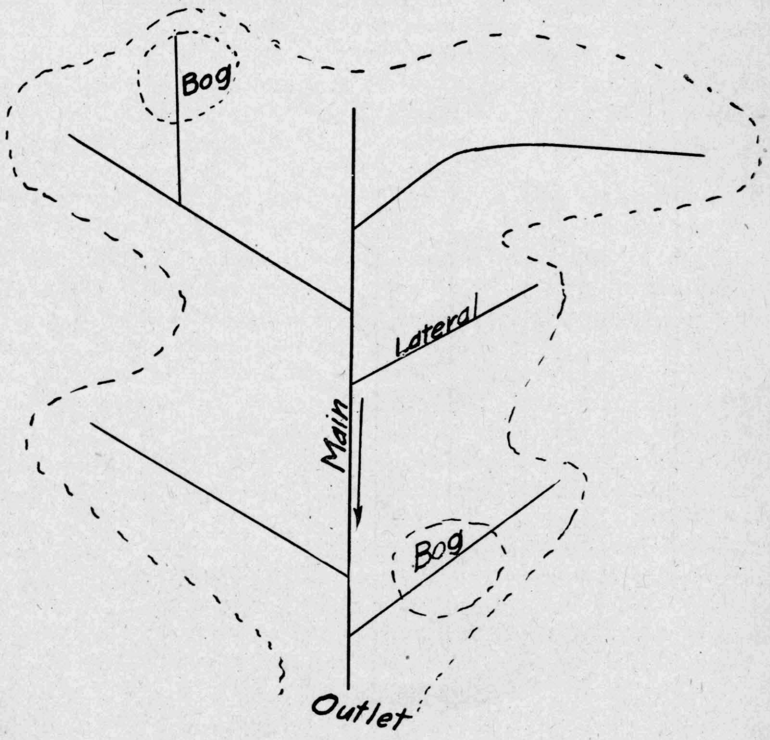


Figure 2. The "Natural" System.

The soils of Texas need immediate attention to stop the destructive washing to which they are becoming increasingly subject as the length of time they have been in cultivation increases. Whether or not these soils should be tile-drained depends on local conditions. Terracing and then seeding down to grasses is advised, but frequently this may not be practicable on account of general agricultural conditions. The construction of terraces and hillside ditches, or a combination of these two methods, is the means most commonly used in meeting the situation. Terracing is all that is justifiable on very cheap land of low fertility. If tile drains were installed the surface soil would gradually become pulverized and little by little more water would be absorbed, thus lessening the injurious flow on the surface. If such land can be thus made more valuable tiling should be done, but in case of poor soil the expense may not be warranted at this time. Where washy soils are of sufficient value, however, terraces should be provided and then tile drains installed.

Irrigated soils which are alkaline need to be drained. As a rule, such lands are valuable. Alkali in injurious quantities is usually caused either by seepage from nearby canals or by reason of too heavy use of water. In either of these cases drainage is the one successful remedy. The surplus water must be drained away and prevented from injuring the crops. Evaporation must be checked, since this loss of water at the surface of the ground leaves behind large quantities of injurious salts.

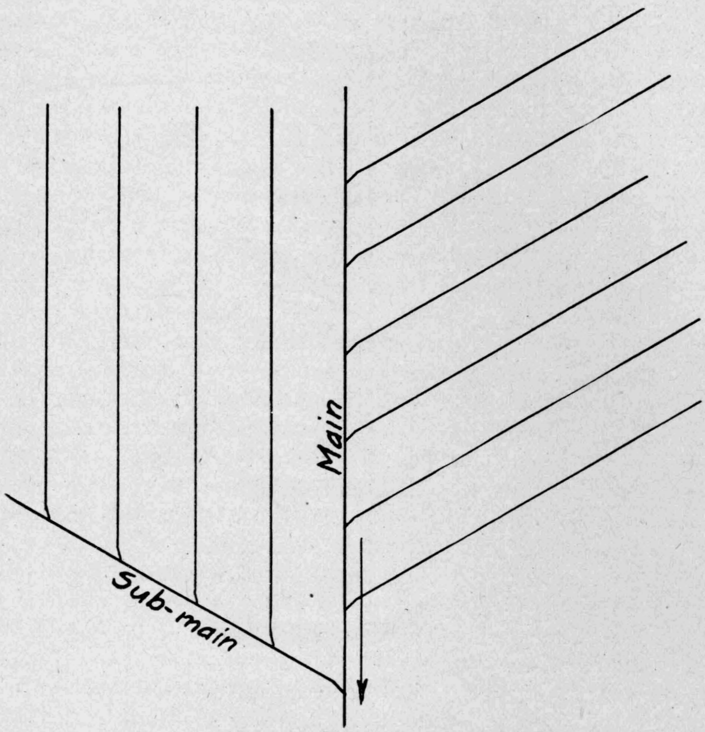


Figure 3. The "Gridiron" System.

## PARTS OF TEXAS NEEDING DRAINAGE.

The accompanying map shows the parts of Texas where drainage of agricultural land is most needed. (Figure 1.) It will be seen that there are two parts of the State where agricultural land is probably in need of drainage. These parts are:

(1) East Texas.

(2) Irrigated soils containing alkali.

There are large areas of deep sandy soils in East Texas which do not need drainage. There are parts of the State where drainage is needed which are not shown on the accompanying map. This is true of the flat areas previously spoken of and especially of the many scattered irrigated valleys.

There are various poorly drained places; many farmers are hardly aware of the wet areas in their own fields that need drainage. Every farmer has thought much about dikes and ditches for some large areas of which he knows, but the drainage problem, on his own farm, is probably being neglected. There is scarcely a farm in the portion of the State indicated in the shaded part of the map that does not have its seepy spots or its miniature swamps. These require under-drainage. Too much water in the soil is robbing the farmer. It shuts out the air and destroys the proper physical conditions which nature herself gives as her part of tillage. It seals up plant food. It makes the ground cold and keeps it cold. It forces the plant roots to the surface and will not let them go deeply. It makes the spring late. It makes the ground dry out very rapidly when hot, dry weather comes. The only remedy is to drain the land.

There must be two and one-half or three feet of a moist but not too wet soil for the roots of the crop. Drainage will give this necessary condition. This will make it possible for the farmer to prepare and keep a warm, friable, easily tilled, moist seed bed for the planting of his crop. If these conditions are then maintained throughout the season a bountiful harvest may be secured.

It is not possible to drain land too well. The water naturally held by the force of capillarity will not drain away. This force of capillarity marks the limit of drainage and no fear need be felt that drains will remove needful water. More water than that which capillarity holds is not needed and is positively injurious. This injurious water we have called surplus water. It may be removed by ditches or by tile drains.

## TILE DRAINS AND OPEN DITCHES.

A system of underground pipes that gives an unobstructed channel for the passage of surplus soil water is called a tile drain.

The surplus water in the soil seeps through the ground to the pipes and enters through the joints, which are "open."

In some parts of the State a system of open ditches will have to be established to provide outlets for tile drains. Open ditches, however, are wasteful of land. They are objectionable because they often make irregular plots of land. This makes cultivation more expensive, for the rows will be shorter and the number of turns in plowing greater. Open ditches are also objectionable because they grow up in weeds. This last objection, however, may be overcome by setting the sides of these ditches to Bermuda grass. The ditches may fill up with silt or sand and require cleaning from time to time.

In sections of heavy rainfall, if the fields are flat, and tile-drained, it will be necessary to supplement the tile drains with open ditches to take care of the storm water. These ditches should be wide and shallow. The field may be plowed in such a manner that the open dead furrows will serve as laterals or feeders to the ditches. Excessive rainfall will then be taken care of without injury to growing crops.

## SYSTEMS OF TILE DRAINAGE IN USE.

There are five different types of tile drainage systems in ordinary use, as follows:

(1) Natural.
(2) Gridiron.
(3) Herringbone.
(4) Double Main.
(5) Vertical.

The "Natural" system (Figure 2) is the type most commonly used.

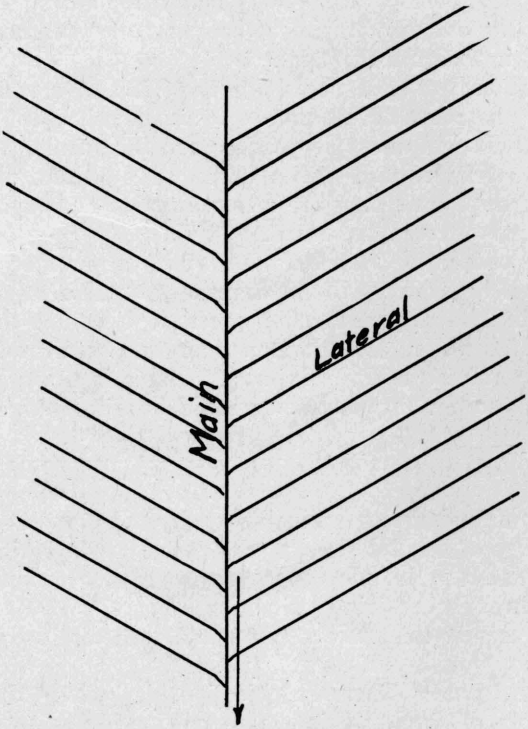


Figure 4. The "Herringbone" System.

The mains and laterals do not follow any general direction, but are located according to the lay of the land and follow the natural drainage. It is usually the most economical of material and requires less skill than the others, in establishing the grades for the ditches. It is not always the most efficient type, but is well adapted to small farms in sections of rolling country.

The "Gridiron" system (Figure 3) gets its name from its appearance. It can best be used where the land is very flat. It consists of a line of tile called a main, running along the edge of a field, and a system of parallel laterals which usually enter the main from one side only, at right angles. The laterals are usually four to six inches in diameter. The main may be ten or twelve inches in diameter, depending on the fall and the number, length and size of laterals emptying into it. Ordinarily, to drain 80 acres by this method an eight-inch main and ten to twelve laterals four or five inches in diameter will be required. In sections where it has been hard to get an outlet, this type has been used. The main must be sunk low enough to drain all the laterals. In case there is no natural drainage for the main to empty into, the water is pumped out on to level wastes, pasture lands, or into shallow ditches.

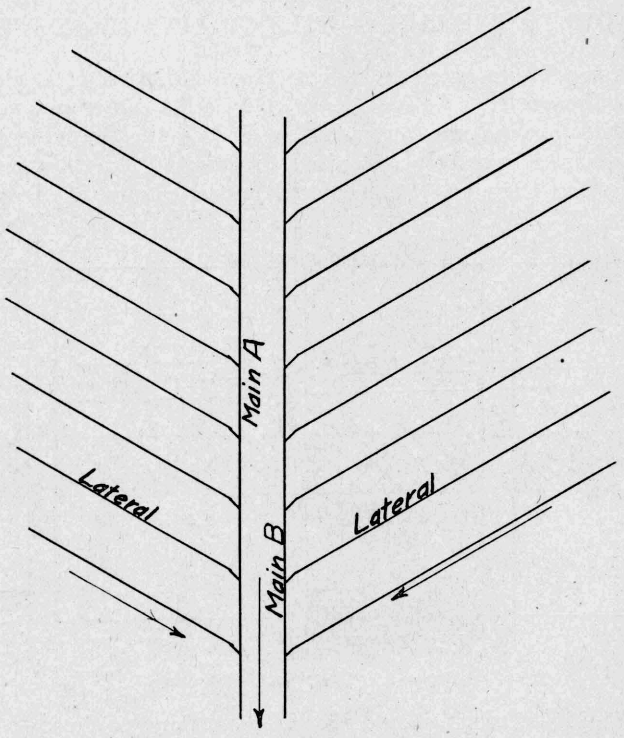


Figure 5. The "Double Main" System.

The "Herringbone" system (Figure 4) also gets its name from its appearance. The main runs through the lowest, wettest part of the land; then this main is fed from laterals running in from both sides at an angle of about 45 degrees. This system is much like the "Natural" system, except that the mains and laterals are all straight, while the "Natural" laterals may have bends in them.

The "Double Main" system (Figure 5) is a modification of all the three preceding systems. It has two mains running parallel to each other with the laterals entering from one side of each main, as shown in the figure. This system can be used to an advantage where a small draw or open drain runs through the land.

The "Vertical" system (Figure 6) is a combination of drain wells connected by drain tile. The idea is to bore to water or until a porous substratum is reached which will absorb the drainage water. This system is not a success in all cases because many soils needing drainage are underlaid by a water table within four feet of the surface during the driest part of the year. The vertical system cannot be used to advantage where the water table is within eight feet of the surface. Vertical drainage usually gives best results on soils underlaid by "hardpan," in seepy places on hillsides, and in narrow draws. It is adapted only to the drainage of small areas. One well cannot be depended upon to drain more than one-quarter to one-half acre.

## HOW TO INSTALL A TILE DRAINAGE SYSTEM.

The first point to be considered in the installation of a tile drainage system is the outlet. To secure an outlet it is sometimes necessary to run the tile through another man's field. (A tile drainage outlet may be secured in a regularly organized drainage district by provision of the law. See Chapter 181, General Session Laws of Texas, 1911.)

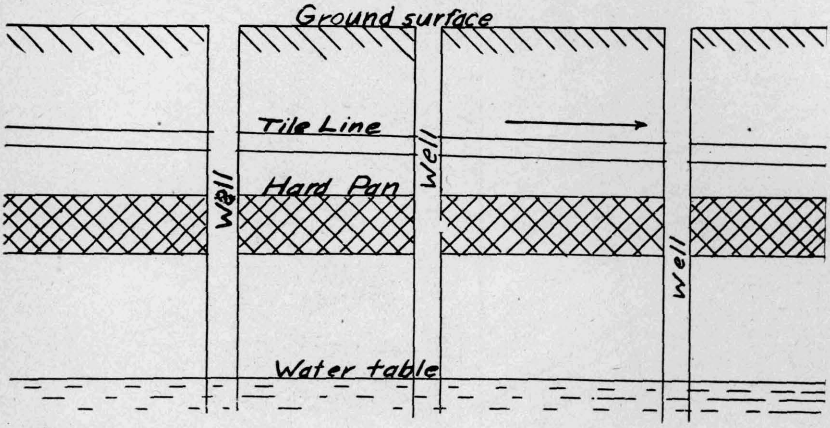


Figure 6. The "Vertical" System.

After deciding where it should be, the next thing to do is to determine where the mains and laterals should run. In this work a farm level, costing about $15.00, may be used. Cuts of these levels are shown in Figures 7 and 8. A list of manufacturers will be sent upon request. Complete instructions come with each instrument. After the location of the ditches has been determined, the grade line is established. Most tile lines are laid with a fall not greater than three inches to 100 feet. If greater than a three-inch fall is given, the water in the tile has such a high velocity that it will cause eddy currents at each joint in the tile. This will dissolve the soil around the joints, causing the ditch to cave in. If less than one-inch fall be given, the flow or velocity of the water in the tile will be so slow that there will be a tendency for the tiles to fill up.

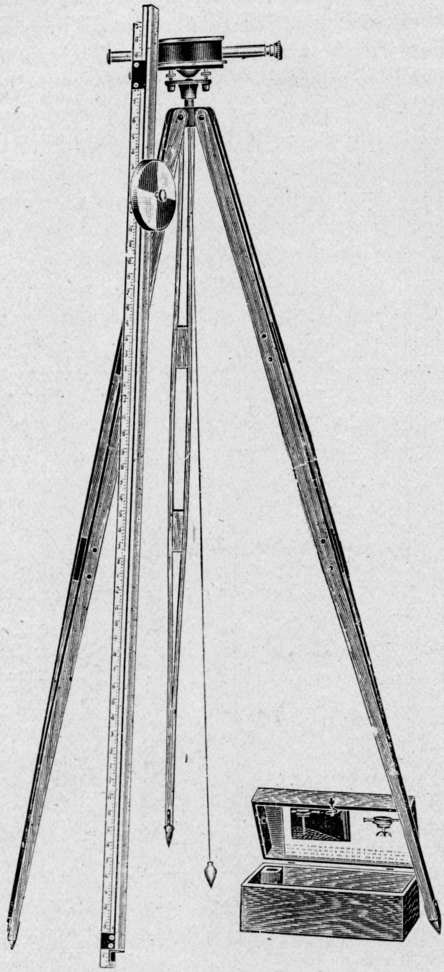

Figure 7. Farm Level.

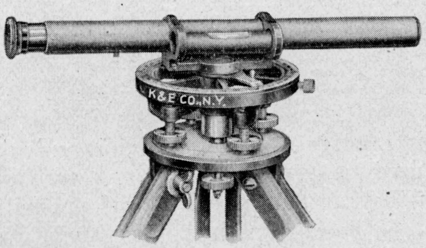


Figure 8. Farm Level.

The ditch should be laid out with a line and stakes driven every fifty feet. The depth the ditch is to be dug should be marked on every stake. When one is ready to dig the ditch a second set of stakes is driven on what will be the edge of the ditch; a line is fastened on these stakes in such a manner that it will be parallel with the bottom of the ditch. All of the above explanation contemplates the use of a level. Where the topography of the land is such that an experienced laborer can tell that his ditch will drain, it will not be necessary for him to mark the depths on each stake. In many places the land is so wet that the laborer will be able to get his grade from the water in the bottom of the ditch. Under such conditions the man who is to dig the ditch can start at the outlet and follow the line of stakes, letting the water that seeps into the ditch give the grade line. While it is necessary that the bottom of the ditch be uniform it is not as difficult as one might suppose to get a ditch that will receive the tile and convey water away successfully. Water will run through tiles that are in an uneven ditch, but the tiles are likely to clog up. Tiles laid with irregularly placed joints will not carry the water away as fast as a system that has smooth joints.

## TOOLS USED.

The tools used in digging the ditch are ditching spades, bar spades, and tile scoops. The ditching spades have short handles, and blades four to six inches wide and eighteen to twenty-four inches long. (Figure 9.) In wet, sticky soils a bar spade may be used (Figure 10), that is, a

Figure 9. Ditching Spade.

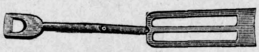

Figure 10. Bar Spade.

Figure 11. Tile Scoop.

spade having a cutting blade welded onto three bars. Such a spade is light and will not lift water with each spade full of earth. A tile scoop is used for cleaning out the bottom of the ditch. (Figures 11 and 12.) This is in the form of a half-cylinder and is sharpened on both ends. It is hung in the center on two brackets, to a handle six to eight feet long. The laborer can stand on the bank and clean out the bottom of the ditch, giving it a smooth, semi-circular form. The ditch will be ready to receive the tile after it has been cleaned out with this tool.

## TILE DITCHING MACHINES.

In a section where a large area of the land needs drainage a ditching machine can be used to good advantage. A machine that will dig a ditch four and one-half feet deep, eleven and one-half inches wide, and dig from fifty to one hundred rods a day, can be purchased for about $1500.00. (Figures 13 and 14.)

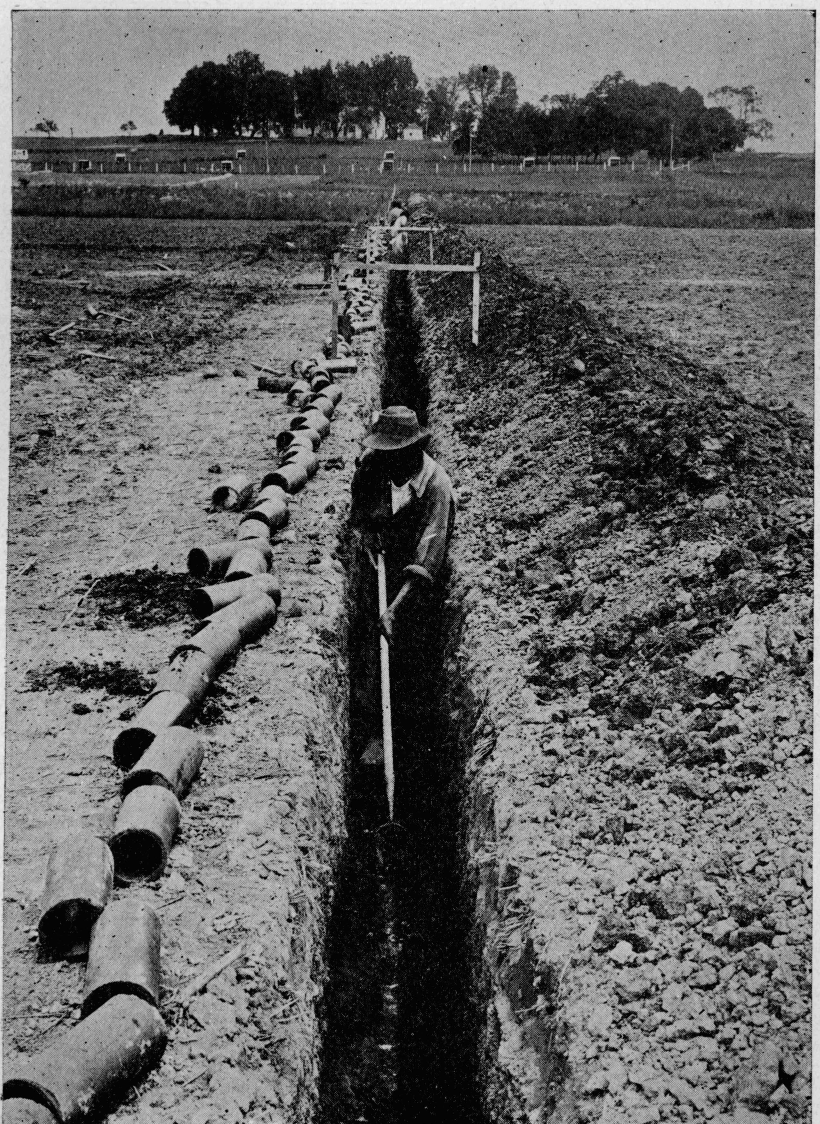

Figure 12. Finishing Grade with Tile Scoop. (Courtesy North Carolina Experiment Station.)

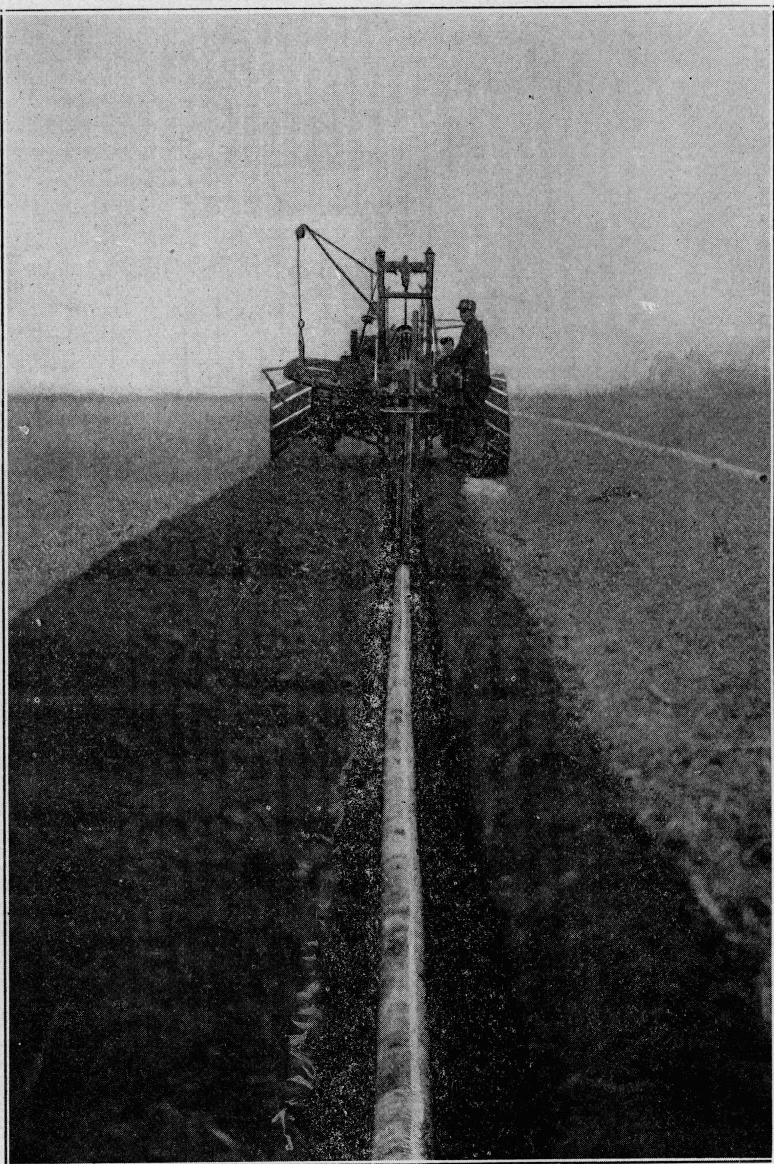

Figure 13. Tile Ditching Machine.

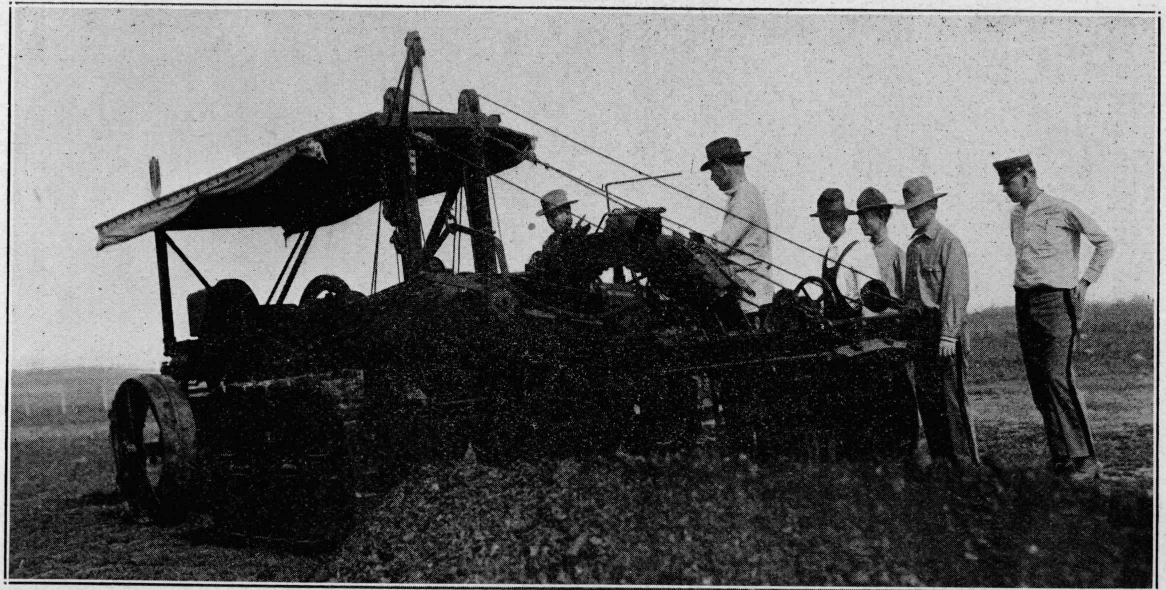

Figure 14. Tile Ditching Machine with Caterpillar Wheels.

## LAYING THE TILE.

The tiles should be strung along the bank of the ditch and if the ditch is not more than three feet deep they can be laid to the best advantage by the laborer standing in the ditch and working backward. He can place the tile in position with his hands. If the ditch is more than three feet deep the tile can best be laid with a hook. (Figures 15 and 16.) The hook can be easily made of one-half inch rod fastened to the end of a hoe handle. The rod is bent at right angles to the handle and the hook should be one foot long. The tile is put on this hook and lowered into the ditch. Care must be used in making the joints of the tile butt snugly against each other. The efficiency of the system will depend on the care used in laying the tile.

If regular "Ts" and "Ys" cannot be secured to join the laterals onto the mains, it is possible to cut holes in the drain tile. In fact, many consider the latter method the most satisfactory manner of joining intersecting lines. To cut a hole in the drain tile a hammer and sharp cold chisel should be used. An outline of the hole is cut in the tile by tapping the cold chisel with the hammer. Follow this outline, cutting in deeper each time until the piece finally cracks and falls out. Whether or not a union is made with "Ts" and "Ys" or by cutting the

Figure 15. Tile Hook.

tile, it is always advisable to cement the joint so formed, since eddy currents are always present at such a point and if the joint is open the earth will be cut out around the tile line, resulting in either a clogged line or a caved-in ditch.

## FILLING THE DITCHES.

It is important not to have much of the ditch open at any one time. Just as soon as the tiles are laid enough fine dirt should be shoveled into the ditch to cover the tiles two to four inches deep. The rest of the ditch may be filled with a plow and team. For this purpose use a long doubletree and place one horse on each side of the ditch. The ditch should be filled as quickly as possible and the ground ridged over the tile to prevent washing.

## OUTLETS.

The outlet of the system should be protected in a permanent manner. The end of the tile should be covered by a swinging cover or a grating that will prevent rats and rabbits from crawling into it during dry times when water is not running through the tile. This can be done by drilling holes in the end of the tile and putting one-fourth inch carriage bolts through the holes. The last tile or outlet should be held in place by a masonry or concrete bulkhead. (Figure 17.) This will prevent the banks from washing away from the tile and leaving the end exposed. The last few joints in the tile line should be sewer pipe and should be cemented. This will prevent any washing around the bulkhead. The head ends of the tile laterals and mains should be covered with gravel or pieces of broken tile (Figure 18) to prevent clogging.

Figure 16. Laying the Tile with Tile Hook. (Courtesy North Carolina Experiment Station.)

## KIND OF TILE TO USE.

The tile most commonly used is the hard burned clay tile. This tile is practically indestructible. It may be used in any soil. Soft burned clay tile may be used in any soil which does not contain acids or alkalis.

The soft burned tiles are porous, and if acid or alkali water is allowed to leach through them they may in time dissolve. Under these conditions hard burned tiles are best. One might suppose it to be necessary for the water to leach through the tile wall to get into the system. This is not true. All of the water that gets into the system goes through the joints. Cement tiles are often used, but as they are ordinarily made on the farm, they present the same difficulty that is encountered with the soft burned clay product. Alkali and acid water leaching through them will destroy them in two or three years. The soft burned clay or cement tile may be used in cases where the soil water is free from acids and alkalis.

## SPECIAL SYSTEMS FOR DIFFERENT TYPES OF LAND NEEDING DRAINAGE.

Alluvial soils, found in the flood planes of rivers and creeks, are usually porous and therefore easily drained. In these soils tile drains op-

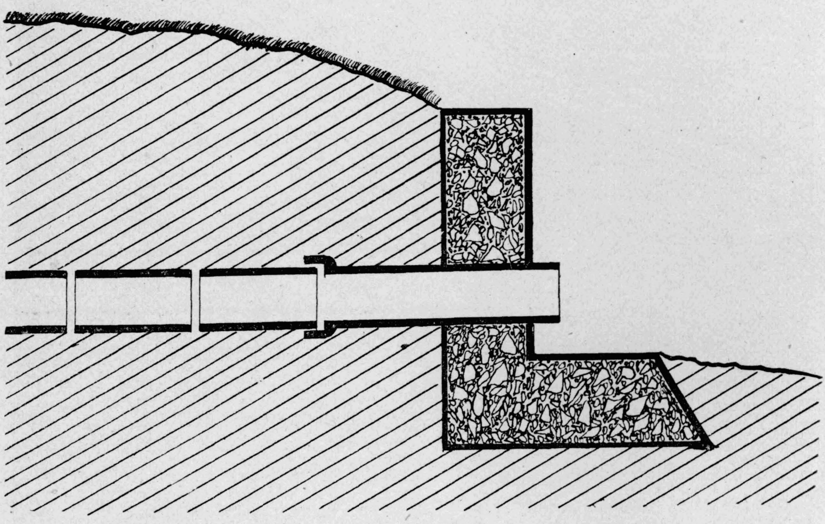

Figure 17. Concrete Outlet.

erate very well when placed twenty-four to thirty inches below the surface. The "Natural" system is the one most commonly employed on these soils. The laterals may be laid 100 to 300 feet apart. The object of a drainage system for such areas is not to prevent overflows, but to dry the land out quickly after a flood or heavy rain.

In heavy clay soils the titles must be laid shallow,—twenty to thirty inches deep,—and, to do effective draining, it is often necessary for the lines of the tile to be from 50 to 150 feet apart. The "Herringbone" and "Gridiron" systems may be used to a good advantage in these soils, as they are usually quite flat and regular.

In sandy soils the tile lines may be placed three to four and one-half feet deep and the lines 100 to 300 feet apart.

Soils that are underlaid with an impervious clay subsoil are very difficult to drain. Good results have been obtained by placing the tile in ditches, three to four feet deep, and covering to a depth of eighteen inches with coarse hay or straw. This prevents the subsoil from cementing over the tile. In land where quicksand is encountered, it is necessary to prevent the sand from entering the joints and clogging up the system. This problem can be solved by covering the tiles with cinders or fine gravel to a depth of six to twelve inches before filling the ditch with soil.

To get the best results, a tile drainage system should be laid out with every irrigation system that is on heavy land. If lines of tile are laid out by the side of irrigation ditches seepage and the rise of alkali can be prevented. In areas where the alkali has already come to the surface by irrigation seepage, it is necessary to place the tile five feet in depth. As the areas usually are not large, one line of tile through a strip 100 feet wide generally will be sufficient to stop the rise of the alkali. When irrigation water is applied, the alkali that is on or near the surface will be washed out through the tile system.

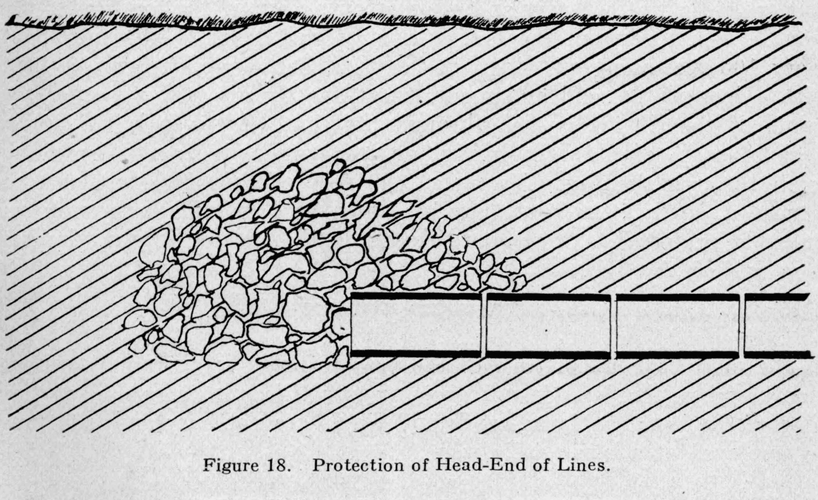

Figure 18. Protection of Head-End of Lines.

The only successful method of reclaiming alkali land is to provide drainage and then flood it with irrigation water. One method is to place the tile in the ditch and then fill the ditch with hay or corn stalks for a depth of twelve to eighteen inches. The ditch should be left open and the land flooded with irrigation water, but the water must not be allowed to flow directly into the ditch from the surface. The water will cause the alkali in the soil to be dissolved and will carry it in solution to the tile drains. After two applications of water the ditch is filled by plowing in the banks.

## COST OF TILE DRAINAGE.

The cost of tile drainage depends to a great extent on the locality. The cost of the tile, together with freight rates, may be ascertained from the manufacturer. A list of manufacturers is kept by the writers and will be given on request. The ditches may be dug, and in fact all of the labor performed by day laborers, so this expense will also depend on local conditions. If the area to be drained is larger than 160 acres, money will be saved if an experienced engineer is employed. An engineer's charge will usually amount to not more than ten per cent. of the total cost of the first systems of a community. Very complete systems have been installed for $15.00 to $30.00 an acre.

## CLEANING OUT OF TILE SYSTEMS.

If it is known at what place the system is clogged, it will be an easy matter to dig up that part and clean it out. But if the location of the trouble is not certain, the best way is to dig down to the tile about every 100 feet along the line. A heavy, smooth wire, say, No. 9, bent with a loop at the end and made smooth so that it will not enter the joints of the tile, is pushed through the line. After it is through a swab of sacks or old rags is tied on the wire and dragged back and forth through the line. To clean 100 feet of line, 200 feet of wire is needed, so that the swab may be drawn back and forth through the line. If preferred, a rope may be used on the swab after the wire has been pushed through.

## TIME TO DRAIN.

The most economical time of the year to drain is during the winter months when the land is not growing any tilled crops. Also, at this time of the year the farm hands and teams are not busy and men may be employed at a lower daily wage.

## DRAINAGE AND PUBLIC ROADS.

The drainage of farm lands has a very beneficial effect on the nearby public roads. This is because of lessening the amount of soil water under the roadbed and also because much of the surface wash off the fields is checked. The land owner, however, must not injure a road by discharging drainage water where it will do damage. The public road laws of Texas make it a serious offense to cause damage to the roads. Therefore, when one contemplates the use of an outlet for a drain in other than a natural drainage course or in a drainage ditch, it would be well to talk the matter over with the county engineer or the road commissioners.